

EXTENDED BURNUP CREDIT FOR BWR SPENT NUCLEAR FUEL IN STORAGE AND TRANSPORTATION SYSTEMS

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ABSTRACT

Oak Ridge National Laboratory and the United States Nuclear Regulatory Commission have initiated a multiyear project to investigate the application of burnup credit (BUC) for boiling-water reactor (BWR) fuel in storage and transportation casks. This project includes two phases. The first phase investigates the applicability of peak reactivity methods currently used for spent fuel pools to spent fuel storage and transportation casks and the validation of reactivity (k_{eff}) calculations and depleted fuel compositions. The second phase focuses on extending BUC beyond peak reactivity. This paper documents work performed to date, investigating some aspects of extended BUC, and it also describes the plan to complete the evaluations. The technical basis for application of peak reactivity methods to BWR fuel in storage and transportation systems is presented in a companion paper.

Two reactor operating parameters are being evaluated to establish an adequate basis for extended BWR BUC, including investigation of the axial void profile effect and the effect of control blade utilization during operation. A detailed analysis of core simulator data for one cycle of an operating BWR plant was performed to determine the range of void profiles and the variability of the profile experienced during irradiation. While a single cycle does not provide complete data, the data obtained are sufficient to use to determine the primary effects and identify conservative modeling approaches. Using data resulting from a single cycle, the axial void profile is studied by first determining the temporal fidelity necessary in depletion modeling, and then using multiple void profiles to examine the effect of the void profile on cask reactivity. The results of these studies are being used to develop recommendations for conservatively modeling the void profile effects for BWR depletion calculations.

The second operational parameter studied is control blade exposure. Control blades are inserted in various locations and at varying degrees during BWR operation based on the reload design. The presence of control blades during depletion hardens the neutron spectrum locally due to both moderator displacement and introduction of a thermal neutron absorber. The reactivity impact of control blade presence is investigated herein, as well as the effect of multiple (continuous and intermittent) exposure periods. The coupled effects of control blade presence on power density, void profile, or burnup profile have not been considered to date but will be addressed in future work.

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